FREP

REPORT #7

April 2007

FOREST AND RANGE EVALUATION PROGRAM

State of Cutblocks: Resource Stewardship Monitoring for Stand-level Biodiversity 2005

BRITISH COLUMBIA
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Resource Stewardship Monitoring

Sustainability of Forest and Range Resources Through Science and Stewardship

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Management of forest and range resources is a complex process that often involves the balancing of ecological, social, and economic considerations. This evaluation report represents one facet of this process. Based on monitoring data and analysis, the Timber resource value team offers the following recommendations to those who develop and implement forest and range management policy, plans, and practices.

Library and Archives Canada Cataloguing in Publication Data

Densmore, Nancy.
State of Cutblocks : Resource Stewardship Monitoring for Stand-Level Biodiversity, 2005 [electronic resource]

(FREP report ; #7)
Electronic monograph in PDF format.
"At head of title: Forest and Range Evaluation Program.
Running title: State of Cutblocks : Resource Stewardship Monitoring for Stand-Level Biodiversity. Co-published by Ministry of Environment, Ministry of agriculture and Lands, and Resource Stewardship Monitoring. Issued also on the Internet. Includes bibliographical references: p.
ISBN 978-0-7726-5744-2

1. Forest surveys – British Columbia. 2. Biological diversity – Monitoring – British Columbia. 3. Habitat conservation – British Columbia. 4. Forest management– Environmental aspects – British Columbia. 5. Forest ecology – British Columbia. I. Thompson, Richard (Richard P. B.). II. British Columbia. Ministry of Forests and Range. II. British Columbia. Ministry of Environment. III. British Columbia. Ministry of and Lands. IV. British Columbia. Forest and Range Evaluation Program. V. Title. VI. Title: FREP Recreation Site Effectiveness Evaluation Project. VII. Series: FREP report (Online) ; #7.

SD438.B7D46 2008 333.7509711 C2008-906021-0

Citation:
B.C. Ministry of Forests & Range. 2005. State of Cutblocks : Resource Stewardship Monitoring for Stand-Level Biodiversity, 2005. B.C. Min. For. Ran., For. Prac. Br., Victoria, B.C. FREP. <http://www.for.gov.bc.ca/hfp/frep/publications/index.htm>

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Executive Summary

This report provides a proof of concept for a provincial summarization of the stand-level biodiversity resource stewardship monitoring under the Forest and Range Evaluation Program (FREP). A general summary is given for the 201 cutblocks sampled during the 2005 FREP field season. This was the first year of operational data collection for stand-level biodiversity. More detailed analysis results are presented for the 72 cutblocks that were sampled in the Sub-boreal Spruce (SBS) zone, where baseline data was available to allow for comparisons to natural trends.

The average total retention found on all sampled cutblocks was 19%. This retention represents all treed areas maintained on block, inclusive of temporary retention and areas constrained for multiple reasons (e.g., sensitive terrain and riparian). A small sampling bias in the 2005 field sampling likely resulted in these retention percentages being higher than actuall. This bias was corrected for the 2006 field season and awerage retention is expected to decrease.

The (SBS) analysis of 72 sampled cutblocks showed some potential biodiversity strengths and weaknesses. Strengths included:

- 42% of cutblocks containing patches ≥ 2 hectares
- 51% of cutblocks had retention with high densities of large trees
- The coarse woody debris (CWD) volume in harvested areas was similar to natural volumes.

Weaknesses included:

- 9% of cutblocks had external retention that is not connected to the harvest area
- 7% of cutblocks had no retention
- 63% of cutblocks had few tree species retained
- Long pieces of coarse woody debris (CWD) were less common on harvested blocks compared to baseline.

Future work will expand the baseline datasets and allow further detailed cutblock analysis. A complete assessment of biodiversity will require a landscape unit assessment of biodiversity values, in conjunction with stand level evaluation.

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Introduction

The Forest and Range Evaluation Program (FREP) was established in 2003 under the direction and guidance of British Columbia's Chief Forester. The purpose of FREP is to assess the effectiveness of the *Forest and Range Practices Act* (FRPA) in the sustainable management of the province's forest and range resources.

Resource Stewardship Monitoring (RSM), one component of the FREP, focuses on monitoring practices in the field. RSM provides information on the status, trends, and implementation issues related to specific resource values, and can help to "red flag" problem areas that may require a change to local practices, or sometimes more intensive investigation.

Stand-level biodiversity monitoring within RSM began in a subset of the Ministry of Forests and Range forest districts in 2005 after a year of testing in 2004. The data collected in 2005 are from the cutblocks harvested between 1997 and 2003. Such blocks were harvested under the *Forest Practices Code of British Columbia Act* (FPC). Monitoring of these FPC blocks allows for later comparison of practices accomplished under the FRPA, and allows for a ramping up of program training and implementation to be ready for FRPA blocks.

The indicators being monitored for stand-level biodiversity are largely stand-structure based. Use of structure-based indicators – along with an adaptive management framework to test their validity to biodiversity, was advocated by Lindenmeyer et al. (2000) as approaches to enhance biodiversity conservation in forests.

This paper reports on the evaluation of a component of the medium filter of biodiversity management – stand-level biodiversity. Because it only contains a single year of data collection, this paper can be considered a "proof of concept." The example given is for the assessment of all Sub-Boreal Spruce (SBS) cutblocks. With further sampling and collection of baseline data, we will assess the sampled cutblocks within each biogeoclimatic ecological classification (BEC) subzone, using a similar procedure as in the (SBS) example.

Background

FRPA – Biodiversity Management

Biodiversity on the public forested landbase is managed under the legislated umbrella of the Forest Practices Code (FPC), which is now transitioning into the *Forest and Range Practices Act*. The FPC *Biodiversity Guidebook* (B.C. Ministry of Forests 1995) introduced the coarse and fine filter approach to biodiversity management. These two general concepts have been expanded into three.

The broadest category of biodiversity management is the coarse filter. This is generally thought of as ecosystem representation (i.e., distinct ecosystems [biogeoclimatic subzone/variants or site series aggregates] represented in their unmanaged state). Old Growth Management Areas are a management tool in this category, as are other techniques that create unmanaged areas over the long term (e.g., ungulate winter ranges, wildlife habitat areas, and physically inoperable areas). Medium filter biodiversity management is the maintenance of stand-level attributes and landscape pattern. Examples of medium filter biodiversity elements at the stand level are wildlife trees, coarse woody debris (CWD), and riparian retention. Landscape-level medium filter elements include seral distribution, patch size, edge, and interior habitat.

Fine filter management is individual species management (for example, wildlife habitat areas for species at risk). Successful coarse and medium filter implementation will minimize the necessity for individual species management through the retention of functioning ecosystems and "life boats" of structural elements. The Forest and Range Evaluation Program (FREP) evaluates all three levels of biodiversity management.

FREP Priority Questions

Eleven resource values are identified under FRPA: soils, biodiversity, riparian/fish, visual quality, timber, forage and associated plant communities, water, wildlife, recreation, resource features, and cultural heritage resources. To focus the monitoring and evaluation activities conducted under FREP, the specific management issues associated with each resource value are identified and questions defined to guide data collection and the ultimate development of accurate and reliable answers.

One goal of FREP is therefore to answer key questions associated with the 11 values identified in FRPA. The answers to these questions will feed into a mechanism for continuous improvement of forest practices, policies, and legislation.

Biodiversity specialists, with input from a broad range of stakeholders, developed a list of questions. Then, members of the Forest and Range Evaluation Working Group (FREWG) (multi branch/agency working group) evaluate this list and choose specific priority questions. One chosen key question guides the process for evaluation of stand-level biodiversity:

Is the structural retention (wildlife trees and coarse woody debris) associated with cutblocks adequately maintaining habitat for dependent species at the site and across the landscape now and in the future?

This stand-level biodiversity question focuses on the important habitat elements of wildlife trees and coarse woody debris. Both of these biodiversity elements are components of the FRPA Forest Planning and Practices Regulation. The main component of stand-level biodiversity evaluation is therefore an assessment of the amount and quality of these two habitat elements.

The assessment of "structural retention...across the landscape now and in the future" is a separate project, which will begin in 2007. This landscape-level project will first focus on determining the local landscape context in which to assess the stand-level retention. An assessment of the quality and quantity of biodiversity elements within an individual harvest cutblock is possible. However, an overview assessment of biodiversity can only be done when:

- there are sufficient cutblocks assessed within a management unit to provide a statistically viable sample,
- these cutblocks have been assessed individually, and
- these cutblocks have been assessed considering their place within the local landscape biodiversity.

In other words, the fact that a single cutblock either contains many or no biodiversity elements does not in itself indicate good or bad biodiversity. The summation of cutblock biodiversity and the character of the uncut portions of the landscape where the cutblocks reside need to be determined before a complete assessment of biodiversity in a forested landscape is possible.

Indicators

The key indicators derived from the stand-level biodiversity data are:

1. **Percentage area retained:** The percentage of area retained as tree cover on a cutblock in relation to the gross cutblock area. This includes wildlife tree patches (WTPs) and dispersed trees and retention on the block that is not labelled as WTP, as long as it is anticipated to be maintained for at least one rotation.
2. **Individual patch size:** Total area in hectares of each separate patch, and area of dispersed retention. Patches are considered large if they are 2 ha or bigger.
3. **Patch location:** Patches can be either *internal* (completely surrounded by harvested area), on the *edge* of the block (partially surrounded by harvest area), or *external* to the block (not physically connected to the block).
4. **Presence of ecological anchors (other than vet trees):** Ecological anchors are such things as hollow trees, cavity nests, and active wildlife trails.
5. **Presence of vet trees:** An estimate of the density of veteran trees (trees that are significantly bigger and older than the harvested stand) for each patch on a cutblock.
6. **Number of tree species retained in cutblock:** A count of the number of tree species remaining.
7. **Wildlife Tree Class 3+ stems per hectare:** Trees classified as Wildlife Tree Class 3–9 are dead trees, with class 3 trees having just recently died.
8. **Big, dead trees:** Must be >30 cm in diameter and 10 m in height. Wildlife Tree Class 3+ stems per hectare.
9. **Stems per hectare large diameter trees (all classes) >50 cm:** Live or dead large diameter trees.

10. **Coarse woody debris (CWD) – total volume per hectare in patch**
11. **Coarse woody debris (CWD) – total volume per hectare in harvest area**
12. **Coarse woody debris (CWD) – number of pieces per hectare >10 m long in patch area**
13. **Coarse woody debris (CWD) – number of pieces per hectare >10 m long in harvest area**
14. **Presence of invasive species:** Include such species as Canada thistle, dalmation toadflax, hound's tongue, and knapweed.
15. **Windthrow:** The percentage of retained trees windthrown.

Indicator 1 (% area retained) tells us how much treed area was left unharvested in a cutblock. Indicators 2 and 3 tell us a bit about the size and location of individual retention patches. Indicators 4 through 9 tell us about the quality of the retained area. For example, we may find out for a particular block that the density of large trees in the retained area is very high compared with the baseline data. This may indicate a good choice of retention areas but it pertains only to the area of the cutblock as determined in indicator 1.

coarse woody debris indicators (10–13) are volume and numbers of long pieces. These coarse woody debris indicators are presented separately for the patch retention (area of no harvest influence) in each sampled post-harvest cutblock and the harvested area (inclusive of clearcut areas and areas of dispersed retention). The coarse woody debris in the patch retention is representative of the (relatively) untouched component of the stand. The coarse woody debris in the harvest area has likely been changed (cut, moved or run over) by the harvest activity.

Many other indicators can be derived from the collected data. The above list of indicators was proposed during the 2005/06 year as a set of basic indicators to be derived and assessed for each cutblock. The data can be further analyzed.

METHODS

Field Protocol

The field methodology for stand-level biodiversity is detailed in the *Protocol for Stand-level Biodiversity Monitoring*. The current version (Version 2, April 28, 2006) is posted on the FREP Web site at: http://www.for.gov.bc.ca/hfp/frep/indicators/table.htm.

The field methodology uses standard field techniques from timber cruising and coarse woody debris line-transect sampling. Plots are established randomly in both the patch retention areas and harvest areas (clearcut areas and dispersed retention areas) of a block. Each plot consists of a tree assessment (species, diameter, height, and wildlife tree class for each tree in the plot) and coarse woody debris assessment (species, diameter, length, and decay class for each log crossed by the transect). Tree assessment is done either within a prism (variable) plot, fixed-radius plot, or full count in a pre-determined area. This flexibility in plot type allows for the most efficient sampling methodology dependent on retained tree density on the block. The coarse woody debris line transect is a 30-m line originating from the plot centre of the tree count plot. coarse woody debris line transects have a 90° bend at 15 m to avoid potential bias from a consistent pattern of coarse woody debris orientation on the block.

After the required plots (as defined in the protocol) are established, an overview is done for every reserve to acquire basic data such as area, location, and stratum type (e.g.,

Measuring tree heights using laser range finder, Central Cariboo.

riparian, wildlife, or other).

Patch summaries and dispersed retention summaries are completed to gather data not readily obtained from plots. For example, a general overview of each patch is done to assess the ecological anchors (e.g., veteran trees, hollow trees, stick nests), constraints on timber harvesting (e.g., riparian, rock, poor merchantability), windthrow, and patch location and size. A final block overview allows the assessor to include qualitative comments for issues that would not be caught in plot data or patch summaries.

District Participation

Generally, Ministry of Forests and Range district staff with participation by Ministry of Environment do the fieldwork. District participation in the RSM program was voluntary for the 2005 field season with 18 districts volunteering. Each of these districts was given a random list of 200 cutblocks chosen from all the potential cutblocks in the population (cutblocks harvested from 1997 to 2003 that were >2 ha). This list was derived from the Reporting Silviculture Updates and Land status Tracking System application (RESULTS). Each district sampled up to 15 cutblocks on its list. A total of 201 cutblocks were sampled during the 2005 field season. This initial year of sampling offered a continuous improvement opportunity before full implementation of the program in 2006 and mandatory involvement of all districts.

Quality Assurance

Quality assurance processes were applied including:

- training of field staff
- tracking of blocks sampled, including checking logic for dropping blocks
- mentoring of field staff on nine blocks
- ongoing questions and answers from field staff to headquarters staff and trainers during the field season
- auditing of results on six blocks
- logic checking of 100% of the field cards
- checking data entry quality on 10% of cutblocks.

Block Assessment

The list of indicators presented can theoretically be used to determine a "biodiversity rating" for each cutblock. Tree-based indicators (e.g., stems per hectare [sph] of WT class 3+, and sph of large diameter trees any WT class) are compared against baseline data collected from cruise plots in the same BEC. Gathering and synthesizing baseline data started in 2005. Only a limited amount of (SBS) cruise data from the BC Timber Sales (BCTS) are available for use at this the time. However, electronic cruise plot data for BCTS are becoming more available and will be used for assessment of 2006 stand-level biodiversity data. Downed wood indicators were compared against a database for mature unmanaged coarse woody debris available on the Ministry of Forests and Range Research Branch Dead Tree Web site. Other indicators (e.g., % retention, presence of ecological indicators) were assessed against best available information as described in the pertinent sections below.

Data Summary: All 2005 Sampled Cutblocks

The total patch retention is 932 ha (see Table 1). Most of this retention (899 ha) is expected to be maintained for the entire rotation (long-term retention). This is based on the assumption that any patch retained for wildlife, riparian, or biodiversity values, and identified as such on the site plan or map, will be maintained at least for the rotation for that cutblock. The total dispersed retention area is 385 ha (this is basal area equivalent area; see description in footnote 1, Table 2). Some 286 of these hectares are expected to be maintained for the rotation. One reason that dispersed retention may be considered temporary is areas of commercial thinning or shelterwood with an expected second harvest.

Dispersed retention, Quesnel.

Table 1. Summary of retention levels (ha) on 201 sampled cutblocks

A	Total gross block area	6916
B	Total patch retention area (includes 33 ha of temporary patch retention)	932
C	Total dispersed retention area[a] (includes 99 ha of temporary dispersed retention)	385
D	Total long-term patch area[b]	899
E	Total long-term patch area that is considered unconstrained[c]	471
F	Total long-term dispersed area[a, b]	286

a Dispersed retention area is given as basal area equivalent area (i.e., a scaling down of the actual dispersed area). It can also be thought of as converting dispersed retention to equivalent amount of solid area retention. For example, if a dispersed area contains 20% of the pre-harvest basal area, then reduce the actual area by 80%. Since we do not have pre-harvest data, the basal area from wildlife tree patches on the same opening, or if no patches, the average basal area for all other wildlife tree patches in the same BEC subzone are used for comparison.

b The area designated as temporary (expected to be harvested before rotation end) has been deleted from these totals.

c Surveyors estimated the percentage of each area constrained (e.g., riparian, low merchantability, or rocky sites). Such sites would theoretically have remained unharvested regardless of being designated for wildlife tree retention.

From Table 1, we calculate that:

- average total retention is 19% [(B+C)/A]
- average rotational retention is 17.1% [(D+F)/A]
- average unconstrained rotational retention is 10.5% [(E+F)/A].

Post-fieldwork quality assurance revealed a bias introduced by some districts, which incorrectly removed cutblocks from sampling if no WTPs were noted in the site plan, or if no streams were on the block.[1] The data presented here include this bias. Data collected in the 2006 field season will include these inappropriately dropped blocks from the 2005 sampling season and therefore correct this bias. As the data currently stand, 7% of the cutblocks had zero retention of any type. This number may increase after the dropped blocks are sampled, and overall retention percentage will likely decrease.

The average size (gross area) of sampled cutblocks with zero retention was 10.8 ha. The average size of sampled cutblocks containing some level of retention was 36.2 ha. This likely indicates that less emphasis is given to maintaining retention on the smaller cutblocks. Lack of any retention on smaller cutblocks is potentially a concern, depending on the area involved.

Indicator values were calculated for each sampled cutblock. Table 2 presents some average indicator values for all the sampled cutblocks in a BEC zone.

Much of the variation shown between BEC zones in Table 2 is likely due to the different productivity and tree life cycles. The veteran trees per hectare and the other ecological anchors were calculated from summary data (non-plot) done on each patch retention area. Some of the ecological anchors are relatively rare elements. Assessors watched for these elements as they move around the block, rather than relying on plot data to represent their abundance. Large-tree densities were calculated from plot data (note that veteran trees found in plots were included with this indicator). Large dead trees are important habitat for wildlife tree users. BC Ministry of Forests and Range (2005) indicated that the minimum size of a dead tree to be functional for bird reproduction is 20 cm dbh and 10 m height. Observations of nesting use of stubs by birds in the southern interior of BC indicated a preference for larger diameter (36–45 cm) (Harris 2001). The 30 cm diameter cut-off for this indicator was chosen because it met the functional dead tree description and was close to preferred diameters. Large trees greater than 50 cm dbh are valuable for long-term structure on a site.

Table 3 compares the average values for coarse woody debris found in retention patches versus the coarse woody debris values found in the harvest areas (inclusive of clearcut areas and areas with dispersed retention) of a particular BEC zone. From the tree data presented above, we cannot determine if the retained patches are representative of tree sizes and state (live or dead) of the unharvested sites. This will require a comparison with baseline data for unharvested areas, and several more years of monitoring. However, we can hypothesize that the coarse woody debris in patch retention is closer to coarse woody debris types and levels representative of the mature forest state than the harvested area. This assumption is tested below with comparisons to baseline data.

Table 3 shows coarse woody debris volume and number of long pieces of coarse woody debris in the retention patches (more natural) versus the harvest area (less natural, particularly if no planning for coarse woody debris retention).

1 This misconception was possibly due to some field staff trying to increase efficiency by only choosing blocks to sample that had both riparian and stand-level biodiversity assessment opportunity.

Table 2. Average indicator value (retained trees and ecological anchors) for sampled cutblocks by BEC zone

BEC zone	Blocks sampled	Avg % retention	Veteran trees (#/ha of patch retention)	Ecological anchors (#/ha of patch retention)	Large[a] dead trees (#/ha of total retention)	Large[b] trees live and dead (#/ha of total retention)
BWBS	16	15.1	0.4	3.5	16.2	14.3
CDF	1	24.0	12	4.2	0.4	51.8
CWH	47	23.7	15.5	5.1	28.1	74.2
ESSF	14	13.9	0.5	1.8	63.7	16.4
ICH	6	29.8	0.3	0.7	24.1	57.5
IDF	20	37.1	22	5.7	1.9	9.7
MH	3	20.0	2.7	2.7	46.4	93.6
MS	7	26.4	3	3.0	2.5	5.7
SBPS	15	7.2	0	0.6	26.0	0.3
SBS	72	13.7	2.8	2.3	22.3	11.5

a > 30 cm dbh and > 10 m in height (patch retention and basal area equivalent dispersed).

b > 50 cm dbh (patch retention and basal area equivalent dispersed).

Table 3. Average coarse woody debris(CWD) indicator values for sampled cutblocks by BEC zone

BEC zone	CWD in patch retention (m^3/ha)	CWD in harvest area (m^3/ha)	# CWD pieces/ ha >10 m long in patch retention	# CWD >10 m harvest area
BWBS	161.5	144.7	128.3	23.6
CDF	147.1	149.7	91.4	17.1
CWH	317.6	311.3	72.6	41.4
ESSF	152.2	152.3	161.9	50.6
ICH	233.7	175.6	111.0	39.1
IDF	63.9	79.2	84.3	51.8
MH	141.6	274.0	55.6	33.5
MS	46.0	67.7	117.7	26.2
SBPS	31.4	41.5	47.5	12.2
SBS	121.8	78.8	126.0	37.0

The general trend is that average coarse woody debris (CWD) volume varies largely between BEC zones (31–318 m^3/ha) in the retention patches and in the harvest areas (41–311 m^3/ha). However, the average coarse woody debris volume in the sampled cutblocks within a BEC zone is fairly consistent regardless of the designation of patch or harvest. The one exception is the Mountain Hemlock BEC zone. However, there were only 3 sampled MH cutblocks.

The most valuable pieces of coarse woody debris are both long and large in diameter. Length has been chosen as the key size indicator since as average length increases, so too does average diameter (Figure 1). The coarse woody debris data were separated into patch retention and harvest area data and average diameter determined for logs in 5 m length classes. For both patch retention areas and harvested areas, average diameter increases as length of log increases.

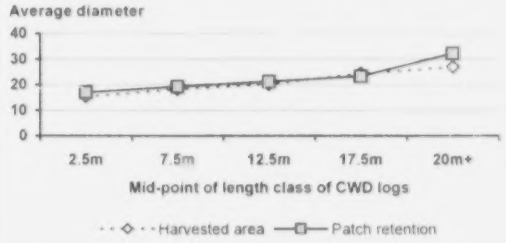


Figure 1. Average diameter by length class of coarse woody debris logs.

Diameter by itself is not as strong an indicator as length (Figure 2). Average diameter increases fairly steadily by length class for coarse woody debris logs found in patch retention. This increase is much less for logs found in the harvest area. The average length by diameter class in harvest area is 4–7 m shorter in the harvest area compared with the patch. This is likely due to the impact of harvest operations shortening logs remaining in the harvest area by breakage and bucking.

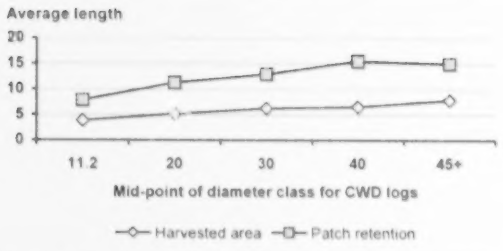


Figure 2. *Average length by diameter class of coarse woody debris logs.*

The average number of pieces of long coarse woody debris, however, does vary a great deal between the patch and harvest areas of a particular BEC zone. The harvest areas have fewer longer pieces of coarse woody debris than the retention patches. This is a particular concern for biodiversity. Long pieces of coarse woody debris are more valuable than short pieces of similar diameter. They last longer (Stone et al. 1998) before they have decayed into soil, and during that time can better perform their habitat and soil stability functions compared with smaller pieces (Harmon et al. 1986). The average number of long pieces of coarse woody debris found on harvest areas is only about one-third of the number found in the patches. A basic biodiversity tenet is that the more a harvested stand can resemble a natural stand, the better it can support biodiversity (BC Ministry of Forests 1995). It is therefore a concern that we are missing long pieces of coarse woody debris on harvested sites.

Comparison to Baseline Data

It is difficult to assess the stand-level biodiversity indicators collected for a cutblock without comparing the data to a pre-determined target representing the desired state. Therefore, the FREP RSM stand-level biodiversity program will collect baseline data that represent the natural unmanaged state (i.e., the desired state is comparable to pre-harvest data) of some of these indicators. Comparisons to baseline data are possible for many of the tree or coarse woody debris indicators. In these cases, baseline data can come from cruise data (for the tree indicators), or research/inventory data (for the coarse woody debris indicators). Many of the indicators whose value is determined by decisions made when designing a cutblock (e.g., % retention, size, and location of retention patch) do not have baseline data. Professional opinion based on the ecological literature was used to assess these indicators.

Some problems still need to be overcome regarding development of a baseline data set. Electronic cruise plot data are not readily available. BEC information is a mandatory component of baseline data but is not normally collected along with the cruise data. BEC data must therefore be separately determined and linked with the cruise plot data. The current focus is to acquire recent BC Timber Sales (BCTS) cruise plot data and cross-reference the government silviculture data system RESULTS to acquire the BEC subzone/variant applicable to the cutblock. To avoid potentially biased baseline data, a full baseline including major licensee cruise data will eventually be necessary. This will require permission from the major licensees and will be followed up in future.

Following is an example using the Sub-Boreal Spruce (SBS) BEC zone cutblocks collected in 2005. The largest number of cutblocks (72) was sampled in the (SBS) and cruise data (with ecological information) were available from 51 recent BCTS cutblocks (1668 plots). coarse woody debris indicators on the sampled blocks were compared against research/inventory data summarized and available on the MoFR Research Branch dead tree Web site. There was insufficient cruise data (or sampled cutblocks) to allow for comparisons at the subzone level – the preferred and eventual comparison. However, the following presentation shows the intent of the block assessments.

Where cruise or research/inventory data are used, the categories assigned represent the four quartiles of available data. For example, Figure 3 shows data from 51 blocks worth of cruise data in the (SBS) zone. The data are sorted in ascending order considering the value of the particular indicator, and presented as a cumulative frequency. For this example of large diameter trees, the first quartile (first 25% of the cumulative frequency) is made up of blocks with less than 1 stem per hectare (sph) of large diameter trees. Therefore, if a population of harvested (SBS) cutblocks had 25% of the blocks showing retention with 0–0.9 sph of large diameter trees, 25% with 1–2.7 sph, 25% with 2.8–6 sph and 25% with 6.1–27 sph of large snags, the percentage of the block with retention would closely mimic natural areas as described by the cruise data.

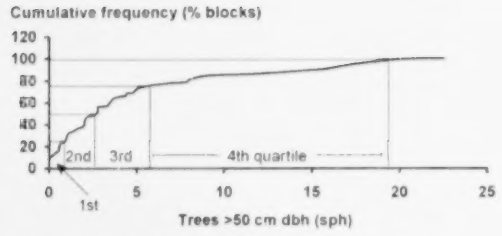


Figure 3. *Distribution of baseline indicator data.*

Large tree, Chilliwack.

Percent Retention

The risk categories presented in Figure 4 change from higher risk on the left of the figure to lower risk on the right. These categories were developed using the professional opinion of the authors considering the conservation literature (Huggard 2006; Angelstam and Andersson 2001). The distribution reflects the current legislated default minimum requirement for wildlife tree retention under FRPA. These categories provide a coarse assessment of risk and need to be considered in conjunction with other indicators of the quality of retention and, potentially with the wildlife species being maintained. Huggard (2006) analysed 51 North American studies of forest dwelling bird species (69 different species)

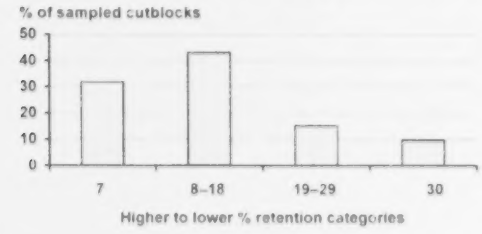


Figure 4. *Categories of total block retention (72 (SBS) blocks).*

and the impact of partial harvesting. The impact of harvesting on the bird abundance was dependent on the bird species and the amount of retention. In summary Huggard suggests that stand retention levels of 15–20% may be sufficient to maintain abundance of those bird species that are of low sensitivity to harvesting. Other more sensitive species would require retention at >40% of the stand for species abundance to be maintained.

The highest risk category was ≤7% retention category. Five of the 72 blocks (7%) had no retention. These five blocks are part of the highest risk to biodiversity category for this particular indicator. The lowest risk category was set at >30% retention. All retention found in these (SBS) cutblocks was considered long term – there for the full rotation. About 10% of the (SBS) cutblocks had 30% or more retention. The retention in these 7 blocks ranged from 30 to 65%, with an average of 41.6%.

The calculation of percent retention was the total of all retention associated with the cutblock (temporary retention was included in the calculation of total area of retention) divided by gross cutblock area. Dispersed retention was included as basal area equivalent.

% Retention = (total retention [ha]/gross block [ha]) × 100

Patch Size

Only 1.4% of sampled (SBS) cutblocks had no retention (either patch or dispersed retention), and about 42% contained at least one patch equal to or larger than 2 ha (Figure 5). Of the remaining cutblocks, most contained a combination of patches smaller than 2 ha and/or dispersed retention. The cutblocks containing a large patch may also contain smaller patches and dispersed retention. Delong and Tanner (1996) showed that for 4 fires (each <1000 ha), 49% of the island remnants remaining post-fire were greater than 2 ha. For the (SBS) harvested blocks, 35% of the retention patches were larger than 2 ha. Therefore the percentage of large (>2 ha) retention patches found in the sampled (SBS) cutblocks is somewhat less than this one example from nature.

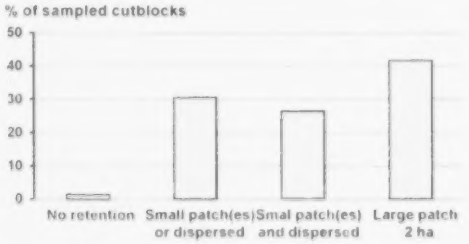


Figure 5. *Categories of patch size/type for 72 sampled (SBS) blocks.*

Patch Location

Data were missing on three blocks. The highest risk to biodiversity is given to blocks with no associated retention patches (Figure 6). The next highest risk is given if the only retention is from external patches. Such patches are not adjacent to the harvest area and may be up to several kilometres away from the block. These are the least desirable patches to maintain stand-level biodiversity attributes. While these patches may contain suitable ecological attributes, they are not considered appropriate since they are not located beside the harvested area and cannot readily offer biodiversity benefits to the harvest area. For example, an external patch cannot provide mycorrhizal fungi, future coarse woody debris, or a seed bank of understorey vegetation to the harvest area. Cutblocks with the lowest risk to biodiversity have at least one patch internal to the harvest boundary, but may also have other patches. Such blocks are assigned the lowest risk, since these internal patches are unquestionably providing stand-level retention and are at lower risk of mistaken harvesting on the next pass.

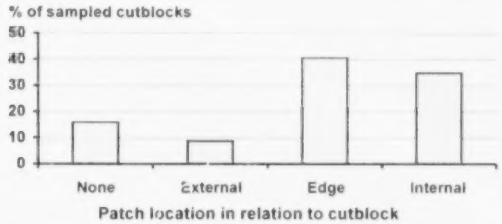


Figure 6. *Patch location for 69 (SBS) cutblocks.*

Presence of Ecological Anchors

Figure 7 shows the density of ecological anchors other than veteran trees that have been noted in patch retention. These data were missing on four blocks. It would be valuable to know what the plan was when the patch was set up, to know if the patch was planned around a snag, a representative area or a den, etc. However, other than bear dens mapped on the site plan map, this information is not readily available. This post-harvest assessment is therefore done to determine a single value for each cutblock (i.e., lumping the data from all patches within a single cutblock). Cutblocks with no patch retention were not included in this assessment. An ecological anchor could be a bear den, hibernaculum, mineral lick, large stick nest, cavity nest, large hollow tree, large witches' broom, karst feature, largest trees for site, heavy natural coarse woody debris accumulation, active wildlife trails, active WLT/ coarse woody debris feeding, or uncommon tree species.

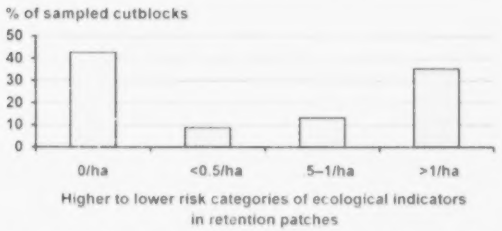
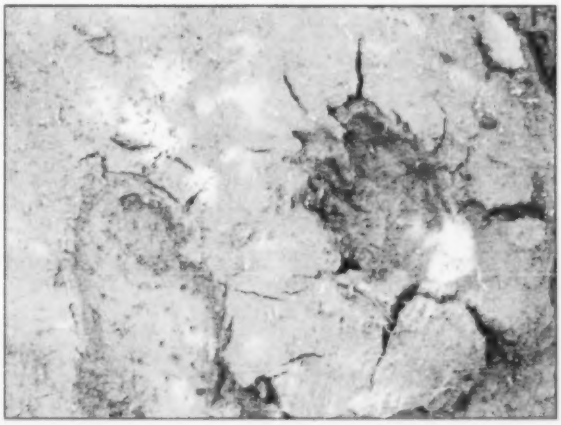


Figure 7. *Density categories of ecological anchors in 68 SBS cutblocks.*

Blocks with no ecological anchors are in the highest risk to biodiversity category for this indicator. Blocks with more than one ecological anchor per hectare of patch retention are of the lowest risk. Such low risk areas may show that areas with good biodiversity attributes have been chosen for retention. This may be the case on 57% of the blocks with patch retention; however, 43% of the sampled blocks that contained patch retention did not have any obvious ecological anchors.



Active wildlife use (bear paw and caulk boot print), Fort Nelson.

Presence or Absence of Veteran Trees on Block

Veteran trees are larger and older than the main stand; for growth and yield purposes, the definition is at least 30 years older. Since veteran trees can be maintained either within patches or in dispersed retention, the assessment for veteran trees was intended to occur on every block. Data on veteran trees were missing for two blocks (Figure 8). A general assessment of presence of veteran trees in the potential pre-harvest blocks is necessary to give context to these

data. However, the timber cruise definition of a veteran tree in the tree class coding system is simply a mature tree, not a "larger and older" tree as defined above. Veteran trees are a valuable biodiversity attribute, providing the upper end of large standing structure and eventually large coarse woody debris. Further work is required to assess if a FREP inventory of veteran trees in post-harvest stands is valuable by itself, or if collecting baseline data of veteran trees in unmanaged stands would allow for a better assessment of the relative "naturalness" of the full range of veteran densities in harvested cutblocks.

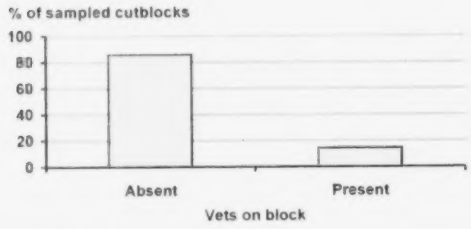


Figure 8. *Presence or absence of veteran trees in 70 (SBS) cutblocks.*

Number of Retained Species

This indicator (number of retained species) was assessed for patch retention (Figure 9). The number of tree species found in the four quartiles of cruise data were used as baseline. Therefore, 25% of the cruised blocks had three or fewer different tree species, 25% had 4 species, 25% had 5 species, and 25% had 6 or more species. The patch retention data did not follow this same trend since 63% of sampled (SBS) cutblocks with patch retention had 3 or fewer tree species. This may indicate a choice of retention patches that are not representative of the pre-harvest, or at this point it may just be representative of insufficient baseline or sample data. Having more cutblocks in the higher categories of species abundance would be more representative of natural conditions.

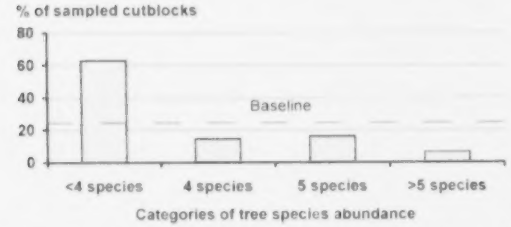


Figure 9. *Category of retained species abundance in patch retention for 62 (SBS) blocks.*

Large Dead Trees

The Figure 10 categories are from cruise data representing the four quartiles of large dead tree abundance from the cruised cutblock data. For the sampled cutblocks to represent the same range of data as the cruise baseline data, Figure 8 should show 25% of the data in each category. However, 49% of the sampled cutblocks were in the lowest category of abundance of large dead trees, 34% in the highest, and 8.5% in each of the middle categories. It is uncertain what the differences are between blocks with relatively high or low density of large dead trees in their retention area other than a generally higher average patch area in the higher density of large dead tree blocks.

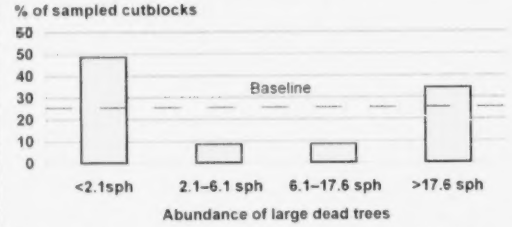


Figure 10. *Abundance of trees WT class 3 or higher, dbh >30 cm and height >10 m for 72 (SBS) blocks.*

A Kolmogorov Smirnov two-sample test was done to test the null hypothesis that the population of (SBS) cruise data for large dead wildlife trees is similar to the population of sampled (SBS) cutblocks. The maximum separation of cumulative distributions (D) is 21.12%. This maximum separation can be seen as the largest vertical distance separating the two lines in Figure 11.

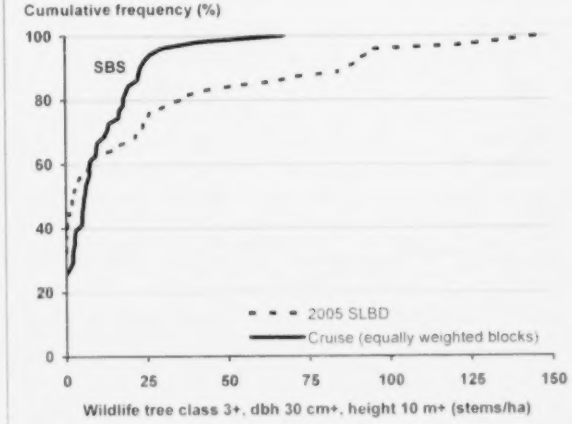


Figure 11. *Alternate comparison of data on large dead tree abundance (retained areas of cutblocks compared with pre-harvest cruise data) for Kolmogorov-Smirnov test.*

Under the null hypothesis that cruise and stand-level biodiversity block means are samples from the same distribution (or population), there is <0.01% chance (Prob ≥ D <0.0001) that the separation would be 21.12% or greater (i.e., a separation value as big as 21.12 is highly unlikely under the null hypothesis of no difference). This result suggests that the two samples arise from different populations or have different sampling biases/precision. These populations are therefore not the same for this indicator; as seen in Figure 10, the differences are greatest on the smallest and largest quartiles of large dead tree density. Many harvested cutblocks have very few large dead trees (unfavourable for biodiversity) and also many having a seeming abundance of large dead trees (favourable for biodiversity).

The (SBS) zone is being changed by the mountain pine beetle (MPB). Further work is required to determine how the effects of the MPB are confounding this comparison between post-harvest retention and pre-harvest conditions as measured in cruise plots. The dead tree component of a stand can obviously change dramatically if comparing post-infestation retention data to pre-infestation cruise data. Such a comparison could certainly account for the apparently large number of blocks with retention containing high numbers of large dead trees.

Large Trees

The Figure 12 categories shown below are from the cruise baseline data. If the retention data were to represent the baseline, it would have 25% of the blocks in each category. As it is there seems to be a higher representation of blocks in both the lowest and highest categories of large tree density within retention areas.

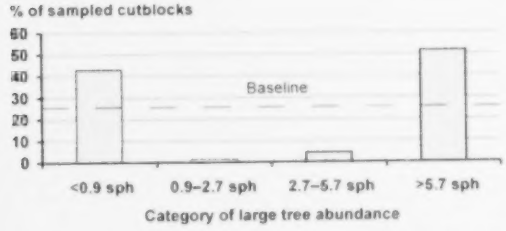


Figure 12. *All WT classes with dbh >50 cm for 70 (SBS) blocks.*

Coarse Woody Debris (CWD) Volume in Patch Retention and Coarse Woody Debris (CWD) Volume in Harvested Area

The Figure 13 categories of coarse woody debris volume come from research inventory data[2] of coarse woody debris volume on mature unmanaged stands for the (SBS). To represent these baseline data exactly, the retention data above would have 25% of the post-harvest sample data in each quartile. Figure 13 shows the post-harvest sample data as separate bars for the patch retention and the harvested area (clearcut area plus areas of dispersed retention) within the sampled cutblocks. Only 46 cutblocks were sampled for coarse woody debris volume in patch retention. This is less than the total sample of 72 cutblocks, since not all blocks had patches and, as well, some districts mistakenly did not collect coarse woody debris data in patches. coarse woody debris volume data in the harvest areas of the sampled blocks were available for all 72 cutblocks, which is fairly close to baseline distribution of coarse woody debris patch retention volume except for the second from lowest category in the harvest areas. These data show that post-harvest coarse woody debris volume within patches is reasonably representative of natural baseline. The distribution of coarse woody debris volume in the harvest area of the sampled blocks is somewhat skewed with few blocks in the highest category of coarse woody debris volume. This result is likely a reasonable distribution if one expects that the highest amounts of coarse woody debris volume should come on areas that have been disturbed naturally and remain unsalvaged. The volume used for this evaluation is total volume of pieces greater or equal to 7.5 cm diameter at the line intersect.

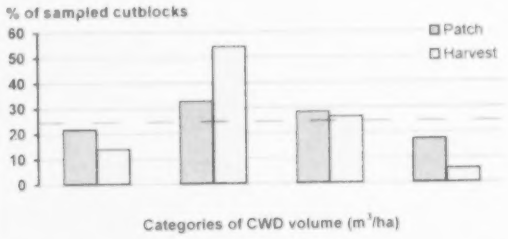


Figure 13. *coarse woody debris volume categories (m3/ha) for 46 (SBS) cutblocks for patch retention, and 72 cutblocks for harvested area.*

2 Ministry of Forests and Range, Research Branch Dead Tree Web site, coarse woody debris database: http://www.for.gov.bc.ca/hre/deadwood/DTdat.htm

Long Pieces of Coarse Woody Debris (CWD) in Patch Retention and Long Pieces of Coarse Woody Debris (CWD) in Harvest Area

The categories come from research inventory data of numbers of long pieces (>10 m) of coarse woody debris on mature unmanaged stands for the (SBS). To represent these baseline data exactly, the retention data (Figure 14) would have 25% of the cutblocks in each category. The sample for this indicator in the patch retention is only 46 cutblocks because not all blocks had patches and some districts mistakenly did not collect coarse woody debris data in patches. The data on long pieces of coarse woody debris in harvest areas was available for all 72 sampled cutblocks. This distribution seems to reasonably represent natural baseline levels for patch retention areas. The amount of long coarse woody debris within the harvested area of the sampled cutblocks is skewed to the second from lowest baseline category.

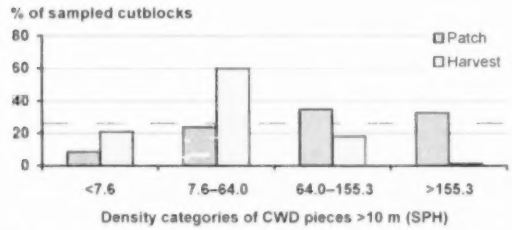
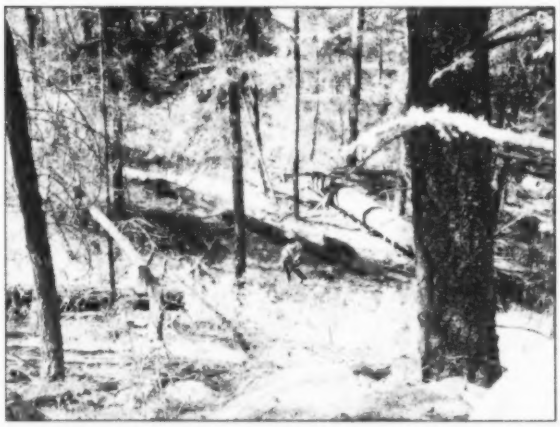


Figure 14. *Categories of numbers of pieces per hectare of long coarse woody debris (46 cutblocks in (SBS) for the patch retention and 72 cutblocks in (SBS) for the harvest areas).*



Long coarse woody debris, Chilcotin.

Presence of Invasive Species

This data element was not consistently recorded and therefore only 57 of the 72 (SBS) cutblocks had data on invasive species (Figure 15). Further work on the methodology (potentially including training for recognition) for invasive plants is necessary and planned for future years. These initial data do not indicate concern regarding invasive plants at this point. Other options for monitoring invasive plant species need to be investigated, potentially with evaluations of other FRPA values. For example, the amount of exposed mineral soil (soils value) may be a pertinent indicator related to invasive plant species.

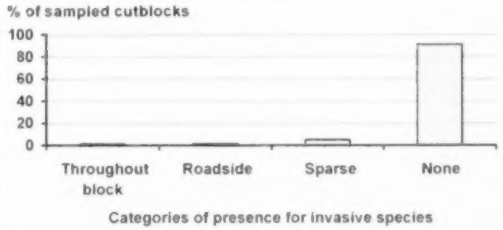


Figure 15. *Categories of presence for invasive species on 57 (SBS) cutblocks.*

Windthrow

Windthrow was estimated for each retention area (patch or dispersed retention) in a cutblock. A single weighted windthrow value (weighted by area) was calculated for each cutblock. Data were not available for two of the sampled cutblocks, though these two blocks had no patch retention in them. As can be seen in Figure 16, most cutblocks had less than 5% windthrow estimated. Mitchell (1995) reported natural endemic levels of windthrow at 4% of allowable annual cut. Though not directly comparable, most cutblocks having less than 5% of retention impacted by windthrow indicate close to endemic levels at the time of sampling. To answer this question, follow up to determine levels of windthrow over the rotation would be necessary.

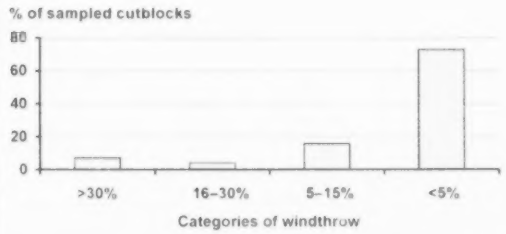


Figure 16. *Categories of windthrow for retention in 70 (SBS) cutblocks.*

Ongoing Work

The amount of baseline data is still very limited and limiting. We are acquiring electronic cruise plot data which has BEC subzone/variant information.

The information management system being developed will allow for more efficient data entry and data analysis and a quicker turnaround on the annual report on stand-level biodiversity. The information management system will also allow for easier dissemination of collected and summarized data. For example, the data set being collected for stand-level biodiversity will be a valuable tool for communication between Ministry and licensee staff when discussing the biodiversity success of a particular cutblock. Data will also be made widely available for further research.

To assess stand-level biodiversity it is necessary to have sampled sufficient cutblocks in a particular watershed or landscape unit and to do at least a cursory landscape-level biodiversity assessment to allow for proper interpretation of the cutblock biodiversity. This work is expected to be in the pilot stage during fiscal year 2007/08.

A complete answer to the biodiversity question will ultimately require a direct research connection between structural retention and the success of wildlife tree dependent species within the landscape. This is necessary to determine if the structural retention can adequately maintain habitat "now and in the future."

Data Summary

There were 201 harvested cutblocks assessed for stand-level biodiversity in 2006. Most of these blocks came from the (SBS) BEC zone (72 blocks) and the CWH zone (47 blocks). Very few (<10) cutblocks were sampled in the CDF, ICH, MH, and MS zones. The BWBS, ESSF, IDF, and SBPS zones had between 10 and 20 sampled cutblocks each.

The average total retention in the sampled blocks was 19.1% of gross area. When factors such as temporary retention and constraints such as riparian reserves are factored, there was an average of 10.5% unconstrained retention. This 10.5% retention was potentially available for timber extraction since constraints to timber harvesting such as riparian reserves, rock outcrops, and wetlands factored out. A sampling bias (some blocks were erroneously omitted from sampling if no retention was indicated on the site plan) discovered during the quality assurance phase is likely responsible for a higher than actual average retention. This average retention is expected to decrease as sampling continues with no sampling bias.

Ninety-three percent of the sampled cutblocks contained some level of retention. The blocks with no retention were generally smaller than blocks with retention. The zero retention blocks had an average gross area of 10.8 ha versus 36.2 ha for blocks with retention. A lack of any stand structure on these cutblocks could be a concern.

An example is shown in this report of comparison of stand-level biodiversity indicators from the sampled cutblocks from the (SBS) zone with baseline data. Highlights of these (SBS) results are shown in Table 4.

Although limited baseline data were available, this example shows preliminary results that may change as both the sampled cutblock size and the amount of baseline data increase. This example for the (SBS) cutblocks shows a good distribution of retention types, with 42% of cutblocks having one or more patches larger than 2 ha. Edge patches on cutblocks (61% of sampled (SBS) cutblocks have one or more edge retention patches) and internal patches (34% of cutblocks have one or more) are both relatively common. The least preferable for stand-level biodiversity, external non-contiguous patches, were associated with 9% of the cutblocks. Most cutblocks (84%) had some patch retention associated. Seven percent of the sampled (SBS) cutblock had no retention at all.

About 63% of sampled (SBS) cutblocks had 3 or fewer species retained, which indicates a decrease in the number of tree species being left in the sampled (SBS) cutblocks compared with baseline cruise data. The abundance of large trees and large dead trees on the (SBS) cutblocks differs from the baseline data in the extremes of the data. There is a higher percentage of sampled blocks both with a very low abundance of these large trees and a very high abundance.

Standing tree and downed coarse woody debris indicators were compared with baseline. When looking at standing tree attributes, the density of a particular indicator within the retained area was compared with baseline. Therefore, a favourable comparison could indicate that the type of retention is representative of baseline but says nothing about whether sufficient area is being maintained. Large dead trees were abundant (compared with baseline amounts) in the retention of about 30% of the sampled cutblocks and very scarce in another 50% of the cutblocks. The density of long pieces of coarse woody debris was fairly representative

of baseline amounts for sampled patch retention. Higher densities of long pieces of coarse woody debris may be under-represented in harvest areas.

Table 4. *Summary of (SBS) biodiversity highlights*

Trend or indicator	Good for biodiversity	Risky for biodiversity
13.7% overall retention (32% of blocks ≤ 7% retention, 10% of blocks ≥ 30% retention)		X
42% of blocks with large patches	X	
9% of blocks with external non-contiguous patches		X
7% of blocks with zero retention		X
84% of blocks have patch retention	X	
63% of blocks with ≤ 3 tree species retained (baseline data showed 25% of the pre-harvest cruised blocks having ≤ 3 species retained)		X
43% of blocks with few large (dbh >50 cm) trees (baseline data showed 25% of the pre-harvest cruised blocks having few large trees)		X
51% of blocks with many large trees	X	
Coarse woody debris volume comparable patch to harvest area and baseline	X	
Long pieces of coarse woody debris less common in harvest area compared with retention patches and baseline		X

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